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o. 86. Issued May 6, 1907.

nited States Department of Agriculture,

BUREAU OF ENTOMOLOGY,

L. O. HOWARD, Entomologist and Chief of Bureau.

THE CORN LEAF-APHIS AND CORN ROOT-APHIS.

By F. M. Webster,

In Charge of Cereal and Forage-Plant Insect Investigations.

The corn leaf-aphis (*Aphis maidis* Fitch) and the corn root-aphis (*Aphis maidi-radicis* Forbes) are together made the subjects of this circular because both attack growing corn, because it has yet to be clearly shown that there is no direct kindred connection between them, though it is possible that they are distinct species, and because this question of their identity or relationship presents itself to almost every observing farmer.

The leaf-aphis does the farmer little direct injury. The root-aphis, on the other hand, sucks the sap from the roots of his corn, thereby causing the plants to become dwarfed, and in serious cases the leaves turn brown and die. In an infested field the corn will be "spotted," as farmers term it—that is, while the plants on certain areas in the field may make a normal growth and may ear well later on, those on other areas will make little growth, but tassel out after they have become a foot or a foot and a half high, producing the almost worthless ears known as "nubbins" or none at all. Thus the damage to the crop in some fields at times reaches 50 per cent or more, and the annual loss throughout the corn belt must amount to well on toward a million dollars. This root-aphis is really becoming the most serious of the many insect pests of the cornfield, especially where a strict system of crop rotation is not carried out.

THE CORN LEAF-APHIS.

The corn leaf-aphis (figs. 1, 2) was described by Dr. Asa Fitch in 1856 from eastern New York, but it is now known to occur from New England to North Dakota and Texas, as well as on the Pacific coast. Besides, it was found by the writer in great abundance on sorghum on the grounds of the Agricultural College of South Australia, at Roseworthy, February 9, 1889. Professor Lowrie, at that time principal of the college, assured the writer that it sometimes became so excessively abundant as to render the plants obnoxious as fodder for

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stock. The insect is known also from Japan. In our own country, while not usually a serious pest, it is said to damage corn, sorghum, and barley in Texas, while Doctor Forbes has noted a reddish discoloration due, he thinks, to a bacterial effect following its occurrence on broom corn.

APPEARANCE AND HABITS.

The corn leaf-aphis is bluish green in color. It appears on corn throughout the Middle West early in July—about the time that the root-aphis begins to decrease in numbers on the roots—sometimes literally swarming on the leaves, husks, and tassels. Here it gives birth to its young, and disappears from the plants only as these ripen and become dry, some individuals even remaining among the husks of belated ears until freezing weather kills them outright.

Whence these insects come, in July, when the first few winged females appear on the leaves of the corn, is a mystery, equaled only

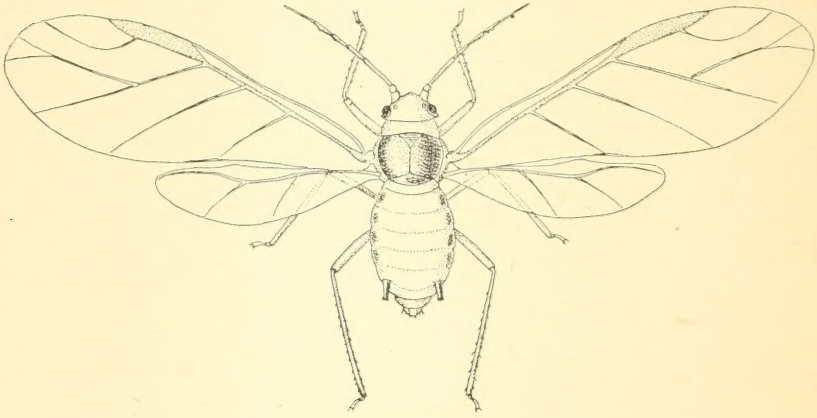

FIG. 1.—The corn leaf-aphis (*Aphis maidis*): Winged female. Much enlarged (original).

by the problem as to the destination of the winged individuals that leave the same plants in autumn. While on the plants they are attended by the little brown ant, the same one that cares for the root-aphis. Thus it will be seen that we have but a fragment of the life cycle of this insect; for, if it is a distinct species, it must occur elsewhere than on corn long before July, and it is equally clear that if distinct it must migrate in the fall to some plant that will afford food for the young the following spring, there to deposit its eggs. We judge this to be the case, as it is known that with most species of aphides there occurs in fall a generation of winged females that fly to the spring food-plant, there to produce a generation of both males and females, the latter laying eggs that do not hatch until spring. From spring until fall there are no males and no eggs; all young

are born alive, after the manner of mammals, and all are fertile females. It will therefore be very clear that with no knowledge of the males and with only this fragment of the life cycle of the females it is impossible to say whether the leaf-aphis is an above-ground form of the root-aphis or whether it is distinct from and wholly independent of that insect.

FIELD EXPERIMENTS.

In October, 1885, the writer transferred some volunteer plants of corn from the field of fall wheat, where they were growing, to some breeding cages. The plants were thickly populated with winged females of the leaf-aphis, and these were carefully secured with the plants, both being subjected to the same conditions which would have influenced them had they remained in the field, except that the ants in attendance were excluded. On May 8, 1886, corn was planted in these cages and grew therein till after the 15th of June—when it was thrown out—without a single individual of either root or aerial form of the root-aphis being on or about the plants.

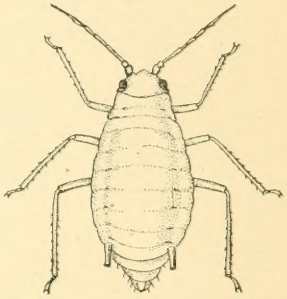

FIG. 2.—The corn leaf-aphis (*Aphis maidis*): Wingless female. Much enlarged (original).

Dr. S. A. Forbes, State entomologist of Illinois, under whose direction most of the investigations of these insects have been carried out, in summing up the results of a long series of carefully conducted experiments of his own, comments as follows:

> The foregoing data confirm our ignorance more than they increase our knowledge, showing, as they do, the failure of all attempts to find or produce a bisexual generation or an alternative food plant of *Aphis maidis*, or to learn how and where it normally passes the winter. Its willingness to feed on winter wheat and ability to breed freely on that plant, its indisposition toward grass or the foliage of the apple, and the natural frequency of successive generations, are the principal other facts evident from these observations.[a]

Winged females of the root-aphis occur in summer on the leaves of corn together with those of the leaf-aphis, but never in such immense numbers. The two forms of winged females seem to be distinguishable, but the sexes have never yet been observed to interbreed—indeed without males above ground they could not do so; hence it is yet too much to say whether there are two distinct species, with the males of but one yet discovered, or whether these are two forms of a single species, with as yet undiscovered relationships obscured by long-continued influences of ants. As it is with the root-aphis that the farmer has most to do, that species will be chiefly considered here.

[a] Twenty-third Report, State Entomologist of Illinois, p. 133, 1905.

THE CORN ROOT-APHIS.

Although the corn root-aphis (figs. 3, 4) was not definitely described until 1891, its presence in the cornfields of Illinois was noticed by Mr. B. D. Walsh in 1862, near Rock Island, and these two corn aphides were made the subject of a paper contributed by him to the Transactions of the Illinois State Agricultural Society.[a] Mr. Walsh, who was afterwards the first State entomologist of Illinois, stated that his attention was called to the "lice" on the roots of corn in this field in the latter part of May, 1862, and about a fortnight later he visited the field in person. He illustrates a section of corn root "as I saw it with my own eyes, swarming with these tiny pests." Further, he states that from wingless specimens, secured at the time of his visit, he afterwards reared 15 winged females. From the fact that the description of the leaf-aphis by Doctor Fitch "agrees

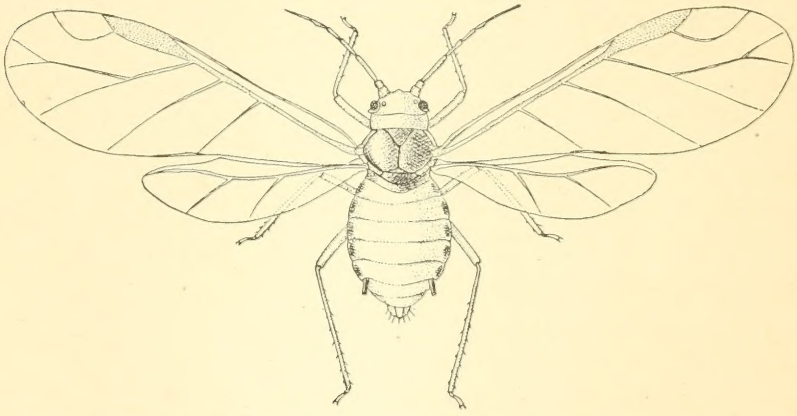

FIG. 3.—The corn root-aphis (*Aphis maidi-radicis*): Winged female. Much enlarged (original).

tolerably well" with that of the species that he found attacking the roots in June, he suspected that the two were identical. An illustration of the winged female reared from the roots does not, however, tend to convince one of the correctness of his opinion, as it best represents the winged root-aphis and rather sustains the fact that the root-aphides were present on the roots of corn at that time, in the vicinity of Rock Island, and that from some of these he succeeded in rearing winged adults in June. While this is not in the least surprising it is nevertheless interesting as being a record of the original discovery of the root-aphis and of the discovery and rearing of the winged female. The statement made that the root-aphis was attended by little brown ants is still further evidence of the validity of these observations, however incorrect Walsh's conclusions therefrom may have been. As a matter of fact, up to about that time spring wheat culture had domi-

[a] Vol. 5, pp. 491–497, 1861–64.

nated over the prairie country east of the Mississippi River and north of the Ohio River, so that conditions were not favorable for the root-aphis. But about that time conditions changed and corn culture became dominant, necessitating the continued cultivation of large areas to this latter grain for a greater or less number of consecutive years. Thus this pest was brought into continually increasing prominence, and Mr. Walsh's observations were made about the time of what was probably the beginning of its career of destructiveness.

DESCRIPTION.

For all practical purposes the root-aphis may be sufficiently characterized as follows: The color is bluish-green, slightly whitened by a waxy bloom. The body is oval, and on the anterior part of the back are two short, slender, rather conspicuous cornicles or tubes, either standing erect or projecting slightly backward (fig. 4). The winged female (fig. 3) has a black head and brownish-black thorax, the abdomen being pale green, with about three marginal black spots and numerous small dark specks over the surface. The antennæ are dark, with paler tinge at articulations, and the legs are mostly black. The only form of male known is wingless, like the female found on the roots.

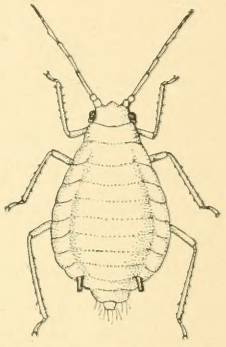

FIG. 4.—The corn root-aphis (*Aphis maidi-radicis*): Wingless female. Much enlarged (original).

THE ROOT-APHIS AND THE LITTLE BROWN ANT.

Before proceeding further it is necessary to describe a most important and astonishing domestic condition involving the brown ant (*Lasius niger* L., var. *americanus* Emery) and the otherwise helpless *Aphis maidi-radicis*. The presence of ants burrowing about young corn plants in the field has frequently attracted the attention of farmers, and damages to the crop are very frequently attributed to them. The species under consideration is one of our most abundant and widely distributed ants, occurring in colonies of from fifty to several hundred in burrows in the fields. While it is of itself harmless, it is in reality responsible for all of the ravages caused by the root-aphis, whose life history and habits it appears to have entirely revolutionized, as will now be explained.

LIFE HISTORY AND HABITS OF THE ROOT-APHIS.

The normal life history of aphides in general is as follows: The winter is passed in the egg state upon or near the plant upon which the young must first subsist in spring. From these eggs there hatch young

aphides that are all females and these in a short time begin to give birth to living young which are likewise all females. Thus the life cycle goes on, and though there is usually a radical change of food plant, there are neither eggs nor males until autumn, when there is a generation consisting of both males and females, the latter depositing eggs that winter over. This egg-laying female and the male are the unknown forms of the leaf-aphis.

Now, taking up the life history of the root-aphis, we find eggs in the fall, it is true, but only in the burrows of and attended by these ants. If there are eggs, egg-laying females, or males elsewhere they have yet to be discovered. The ants care for these eggs throughout the winter, shifting them about, according to Forbes, as they do their own young, to accommodate them to changes of weather and moisture. In spring, the young, as soon as they hatch from these eggs, are transferred by the ants to the roots of young foxtail grass, smartweed, and even ragweed. The young are carried out to pasture, as it were, during fair weather, but in bad weather, or on cold nights, they are taken back to the burrows of the ants. The plants just mentioned are the ones that push up early in spring in last year's corn lands, and especially in fields that have been plowed and allowed to stand untouched for a week or so. Usually the farmer plows his ground in spring and pays little attention to this early growth of weeds and grass, as he can generally dispose of it as soon as he begins to cultivate the corn, although this is not until the rows of young plants can be followed by the eye across an ordinary field. As soon, however, as the corn plants begin to show above ground the ants not only transfer the young root-aphides from the burrows to the roots of corn, but they will also remove them from the roots of grass and weeds and recolonize them on the roots of young corn. Now these young aphides are all females and within a few days they begin to give birth to young, also all females; these, too, are cared for by the ants, which place them on the freshest and most tender rootlets. This procedure goes on about the roots of corn throughout the spring and summer. Forbes has found that under the most favorable artificial conditions there may be as many as sixteen generations between April 8 and October 10, ten of which may coexist at the same time. It is hardly probable, however, that so many generations can exist under ordinary field conditions; nevertheless it may be rightly inferred from this that the multiplication of the species is enormous. These ants not only transfer the root-aphides from one root to another of the same plant, but will carry them from one plant to another a considerable distance away. In the spring of 1887 the writer placed a number of flowerpots containing young, growing, uninfested corn plants between rows of infested hills of corn in the

field. The corn in the infested hills was then pulled up, exposing the roots on which the aphides were clustered. The little brown ants at once began to carry the aphides to new quarters, and the next day the latter, some of them full grown, were abundant on the roots of the corn in the pots, although there were none on them when the pots were put in place. Ants were observed over a yard away from the plants that had been uprooted, with root-aphides in their mouths, to all appearances searching for a suitable place in which to establish their charges on the roots of corn. Thus it is that from the laying of the eggs in fall to the last or egg-laying generation of the following year this aphis is wholly dependent on the little brown ant for its existence in the cultivated fields, and the farmer can justly charge up his losses through the attacks of the root-aphis to the influences of this ant. But the matter does not terminate here, as will be seen by what follows.

WINGED FEMALES OF THE ROOT-APHIS.

So long as the roots upon which the root-aphides are colonized afford an abundance of nourishment for them, all will be wingless, but as soon as the roots become tough and woody or dry out there will be a generation of both winged and wingless individuals, the former escaping from the burrows about the roots to fly to other plants, and in all probability to other fields, where they may be found on the leaves. The ants usually transfer the wingless individuals to more succulent roots, but seem to pay little or no attention to the winged individuals, letting these make their way out and away. But in May, 1887, the writer was able to watch some of these winged nomadic individuals in a cornfield to which they had migrated and to note the results of their wanderings. A field of corn had been planted on May 18. Five days later there came a heavy rainstorm that flattened the surface of the ground, which was soon incrusted by the action of wind and sun. Four days afterwards there were freshly-thrown-up mounds of earth about some of the corn plants, and ants were busily engaged in and about these and running up and down over the young corn. On examining these mounds and burrows the writer was surprised to find winged root-aphides giving birth to young on the roots, attended by ants. All of these young were very small, at most but a few days old. Other winged individuals were found on the leaves and even on the stems of corn, and when any one of these was placed where the ants could find it, it was promptly captured by an ant and transported to the roots of the corn. Observation showed that as soon as the ants running about over the young corn plants found a winged aphis they made a burrow about the base of a plant, and soon domiciled the wanderer on the root under their guardianship. Then when the aphis began to give birth to young these were promptly removed to another part of the same

root or to another root close by, and there watched over by the patient and industrious ants. The same thing was observed going on about a young plant of fox-tail grass in this same cornfield.

INFLUENCES LIKELY TO PRODUCE FEMALES.

While the production of winged individuals seems to be brought about largely by insufficient food supply, Forbes is of the opinion that the production of egg-laying females is fully as much—if not indeed much more—influenced by the temperature, a low temperature causing them to be produced at any time, regardless of generation; and he himself has secured them from as many as five different generations. In two cases recorded by him the first young produced developed to adults that gave birth to their young, whereas the last developed to adults that laid eggs. These cases, although seeming rather out of the ordinary, illustrate the fact that the insect may adapt itself to widely different autumn conditions; that is to say, an early frost, which presupposes a low temperature, kills the corn but does not annihilate the insect, for an egg-laying generation is thus precipitated and the ants promptly secure the eggs. This egg-laying generation is probably produced in September or October, as these females are found in the burrows of ants at that time. Possibly it is produced earlier to the South. Mr. C. N. Ainslie, of this Bureau, one of the writer's assistants, found the egg-laying females quite numerous in such situations on September 22, at Annapolis Junction, Md. The chief item of interest to the farmer is the fact that these eggs are taken charge of by the ants and kept through the winter.

THE ANT'S CARE FOR EGGS AND YOUNG OF THE ROOT-APHIS.

There is no indication that the ants hunt the fields for egg-laying females; on the contrary, they secure their supply of eggs from females kept for precisely that purpose in their burrows about the roots of corn. This affords ample explanation of the increasing abundance of root-aphides in fields that are cultivated to corn year after year in succession, and it also points to a preventive measure. The object of all of this care on the part of the ants is to obtain from the root-aphis a sweet fluid known as "honey dew." Owing to this peculiar relation, this and some other aphides are commonly termed "ants' cows." Thus the economic importance of this insect and its association with ants is for practical purposes fully accounted for and an explanation furnished as to why farmers are misled into believing that it is the ants that actually destroy the corn. Not only this, but a condition of affairs is revealed which shows why this young growth of grass and weeds that springs up soon after the ground is plowed in spring, pre-

paratory to putting out the young crop, and which usually causes the farmer little concern, is really of vital importance. The farmer rests secure in the knowledge that he can easily kill this growth of weeds and grass later. This is true; but he does not do so until his corn has grown to a size that will permit cultivation, and by this time the ants have transferred the root-aphis to the corn. The aphides are then no longer dependent on the roots of the grass and weeds, so that the destruction of the latter at this time does not seriously affect the domestic arrangements of the ants and aphides.

NATURAL ENEMIES OF THE ROOT-APHIS.

While the leaf-aphis is attacked by a host of parasites, the root-aphis does not appear to suffer in the least from inroads of either parasitic or predaceous insect enemies. This is, perhaps, owing in part to the protection offered by the ants. All natural checks must therefore be meteorological influences, and, as previously shown, these also are to a marked degree overcome by the watchful care of attendant ants.

PREVENTIVE AND REMEDIAL MEASURES.

Preventive measures deal with the pest prior to its becoming established on the roots of corn in the fields; remedial measures, with disposing of it afterwards.

CROP ROTATION.

From the fact that in the midst of the corn belt, and where the root-aphis is known to prove destructive under certain conditions, almost complete immunity is secured where a system of crop rotation has been carried out for many years, involving but one corn crop in the cycle of rotation, it is self-evident that this measure offers the greatest protection from the ravages of this pest. Indeed, it is only where such a system of crop rotation is not practicable that the root-aphis need be considered in farm practice. To the eastward, where there is more general rotation of crops, this pest does but little injury.

Unfortunately, local conditions, often extending over large sections of country, will not permit of crop rotation being generally adopted, and some other plan more feasible must be put into practice. Two other methods may be followed. One of these is practicable throughout the corn-growing section of the country in seasons of not more than normal precipitation during the time intervening between the first plowing of the ground and the first cultivation of the young corn. The other is perhaps best adapted to the southern portion of the country on account of the milder winters.

STIRRING THE SOIL AFTER PLOWING AND BEFORE CULTIVATING THE CROP.

The action of the ants in colonizing the young root-aphides on the roots of young grass and weeds that spring up in the fields almost immediately after plowing in spring has already been explained. Indeed, this is the only pasturage for young root-aphides that is available at that particular period, and if this can be destroyed the pest can not survive until corn roots are available. If, then, the ground is frequently stirred from the time it is plowed until the first cultivation takes place, not only will this pasturage for the pest be destroyed, but the homes of the ants will be continually broken up and a greater or less number of their own young, as well as the young root-aphides, will be killed, while many unhatched eggs of the pest will be destroyed or lost to the ants. This measure involves additional labor, it is true, but in the writer's experience it has proved effective, and, besides, every up-to-date farmer knows that the more the soil is stirred, pulverized, and compacted prior to the first cultivation, the more thriftily will his crop grow when it is fairly started and the more grain will it produce. So, then, the extra labor involved in this practice is not without ample return, aside from the fact that it demoralizes the ants and destroys the root-aphis. The only sections of the country where this is not strictly true are some portions of the South, where the planter must endeavor to curtail the growth of stalk in order to secure larger and more perfect ears. But here, again, corn is not the major crop, it is not grown for several consecutive years on the same ground, and the root-aphis is not so excessively abundant.

LATE FALL OR WINTER PLOWING.

It is in the southern section of the country that the second preventive measure, i. e., late fall or winter plowing, can be best applied. In the corn belt of the more northern section of the Middle West, not only is winter plowing, as a rule, utterly impracticable on account of the more severe weather, but the fodder, instead of being secured as in the East and South, is pastured off after the corn has been husked. To practice late fall plowing, or indeed to fall-plow at all, would mean, therefore, in this northern section, the sacrifice of this important item in farm economy. As far north at least as the latitude of Washington, however, winter plowing is frequently entirely practicable, and there is little doubt that it will prove entirely effective against the root-aphis.

During the winter of 1906 Mr. John Bowie, of Annapolis Junction, Md., winter-plowed the major portion of a 60-acre field in preparation for corn the following season. The plowed portions occupied each of two sides of the field and a narrow headland at one end; thus the unplowed area was left in the middle of the field and this was plowed in

the spring. On July 28 the writer went over this field of corn carefully and found that over the spring-plowed portion nearly every hill of corn was infested by the root-aphis. The crop was an almost complete failure. Much of the corn had been killed out previous to the time of the writer's visit and the remaining part was dwarfed in growth, bore few ears, and such as it had were very small and almost worthless. All over the winter-plowed portion, however, there was every prospect of a heavy yield of both stalk and ears, even to the narrow headland previously mentioned. An assistant, Mr. Ainslie, visited the field in late September and was able, without information from any person, to locate, to a row, the dividing line between the two plowings. This was clearly visible on account of the difference in appearance in the stubble—the corn having by this time been cut and shocked—and also on account of the number, size, and appearance of the shocks. There was a difference of fully two-thirds in favor of the winter-plowed portions of this field. As the yield of the winter-plowed portion was approximately 75 bushels per acre, the spring-plowed would not exceed 25, showing a probable loss of about 50 bushels per acre. At the market price, 75 cents per bushel, the loss would amount to $37.50 per acre, to which must be added the loss in fodder. These figures show quite conclusively the amount of damage this root-aphis is capable of doing, as well as what can be accomplished in the way of prevention by thoroughly practical methods.

THE USE OF BARNYARD MANURE.

It seems to be a fact, borne out by field observations, that where ground has been fertilized with barnyard manure the root-aphis does not become so destructive. As far back as 1886, on the experiment farm of Purdue University, at Lafayette, Ind., the writer made some observations which led to the conclusion that proper fertilizers applied to the soil are a general preventive of damage. This was clearly proved by the appearance of the crop on a series of eighteen plats on the university farm. These plats were located side by side and numbered 1 to 18. All had produced corn for the previous six crops, those plats of even numbers not having been fertilized during that time. Plats 1, 7, and 13 had, three and again two years previous, received applications of gas-lime; plats 3, 9, and 15 had received applications of superphosphates during the same years, while plats 5, 11, and 17 had received similar treatment with barnyard manure. The result, up to July, 1886, was that the corn on all plats except those fertilized by barnyard manure was small and uneven in growth, while on plats 5, 11, and 17 the plants were fully a third larger, more thrifty, and far less uneven in height. In fact, these plats could be distinguished from any of the others at a distance from the field. It was unfortunate

that the carrying on of the experiments forbade any examinations of the roots in order to estimate the relative number of aphides inhabiting each series of plats.

EXPERIMENTS IN DRIVING THE ANTS FROM THE ROOTS OF CORN IN THE FIELD.

During June, 1886, a number of experiments were made to test the immediate effect of fertilizers, including salt, upon the aphides, and also to learn if the ants could be induced thereby to abandon or remove their favorites to other plants.

The substances used were two commercial fertilizers (Bunner bone dust and bone guano), barnyard manure, and common salt. A double experiment was made with each. The first two substances were applied (1) by scattering a tablespoonful on the surface of the ground about the plant and sprinkling with water sufficient to wash it at once into the soil, and (2) by drawing the earth away from the roots, scattering the same amount of fertilizer about the roots, then replacing the earth, and sprinkling the surface less thoroughly than with the first. The barnyard manure was well-rotted and a quantity sufficient to fill a pint measure was used in the same way. The salt was used in the same way as the manufactured fertilizers.

The result, a week after, was that the "lice" were still about the roots in every case, and, except where salt was used, they were found in the midst of the substances applied. The salt only drove them from one portion of the roots to another. Sand dampened with kerosene was then applied in the same way, but the surface application had no effect, and that made directly to the roots only drove the aphides from one part of the roots to another, as did the salt.

TREATING THE SEED BEFORE PLANTING.

During the last two years Doctor Forbes, in Illinois, has been testing a great number of substances with a view to treating the seed with some repellent that would render it so obnoxious to the ants that they would not place the aphides on the roots of the young plants. It has indeed seemed possible to take advantage of the well-known fastidiousness of these ants and find something that, applied to the seed, would not injure its vitality, but would give off an odor so disagreeable to the ants that they would shun the vicinity of its application. The writer tried something of this sort in 1887—except that in his experiments substances supposed to be offensive to the ants were placed in the soil about the roots of the corn—but the results were not satisfactory. In treating the seed, however, Doctor Forbes seems to have had very encouraging success and he has permitted the writer to use here the results of his experiments, which are quoted in brief as follows:

The substance found most effective for the treatment of seed corn was a mixture of oil of lemon and wood alcohol. To 1 gallon of wood alcohol add 1 pint of oil of lemon, and sprinkle and thoroughly stir 3 fluid ounces—that is to say, 6 tablespoonfuls—of this mixture into each gallon of corn shortly before planting, making sure that the fluid is equally distributed and that each kernel of corn has its proper share. A thorough stirring after the application of the mixture is all that is necessary. The odor of this compound, which will last for weeks in the ground, is extremely offensive to the cornfield ant, and these insects will not enter corn hills as long as it continues. As the root lice can not get access to the corn or maintain themselves there except by the aid of the ants, the hills remain virtually free from both insects for at least six weeks.

The wood alcohol should not cost more than $1 a gallon nor the oil of lemon more than $2 a pint, and the above amount of the mixture will be sufficient to treat the seed for 45 acres, making a cost for materials of less than 10 cents per acre. Care should be taken to buy these substances from thoroughly reliable druggists, the oil of lemon especially being subject to adulteration. If the mixture is not entirely clear when shaken up the materials are impure.

Doctor Forbes has in some cases succeeded by this means in reducing the number of root aphides 89 per cent and the number of ants 79 per cent, which is certainly a very creditable showing for this mixture. The mixture of wood alcohol and oil of lemon is so easily made and the application so inexpensive and simple that it is to be hoped that farmers who have suffered from the ravages of this pest will give the preparation a thorough trial in their fields. While local conditions may prevent the putting into practice of any or all of the other measures of relief here advised, it is difficult to conceive of a situation that would prevent a farmer from treating his seed corn before planting, as recommended.

Approved:

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *April 5, 1907.*

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